

Mobile Exploration System

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The Mobile Exploration System (MEX) research project is a distributed information system designed to assist planetary exploration operations that consist of three primary nodes with unique computational capabilities appropriate for its operational function, linked together via high-speed radio communication systems. The three nodes include a science center node, a base camp node, and a mobile node, which are packaged to endure the rigors of wilderness traverses. Each operational node allows humans at that location to participate in the exploration activity. Figure 1 shows the three nodes schematically.

The science center computational node, supported by several Web and video teleconferencing servers, represents the Earth-based mission control and planetary science data systems. Consultation with remote institutions and scientists is supported via Internet-based collaboration tools.

Housed in the base camp work tent, the second node represents the planetary habitat that will act as the primary point of contact for explorers engaged in extravehicular activities. This node consists of a series of workstations and data servers supported by a wired local-area network. It is linked with the science

center using two geosynchronous satellite links, one using a commercial C-band service, and the other using the Advanced Communications Test Satellite. Tests of satellite link quality at high latitudes (75°) were performed as part of the FY99 Houghton Mars Project field tests at Houghton Crater.

The third node is the mobile exploration computation and communication system. This mobile node is connected to base camp using two medium-range radio links, dubbed the Crater Area Network (CAN), which consists of a medium-rate omnidirectional radio system for vital communication and control, and a high-rate network packet radio supporting video teleconferencing with real-time monitoring of high-resolution cameras and instruments. This dual-link communication model is similar to that used for planetary spacecraft; it incorporates the best features of both types of radio systems. The CAN was field tested by setting up repeaters on a high hilltop two miles from base camp and using an all-terrain vehicle (ATV) to test link quality and reliability in different locations.

A human-centered system design approach is being used for the development of the MEX, focusing on the explorers who conduct field geology and biology surveys, and incorporating the results of work practice studies being conducted at Ames. The mobile node has a server computer, mounted on the

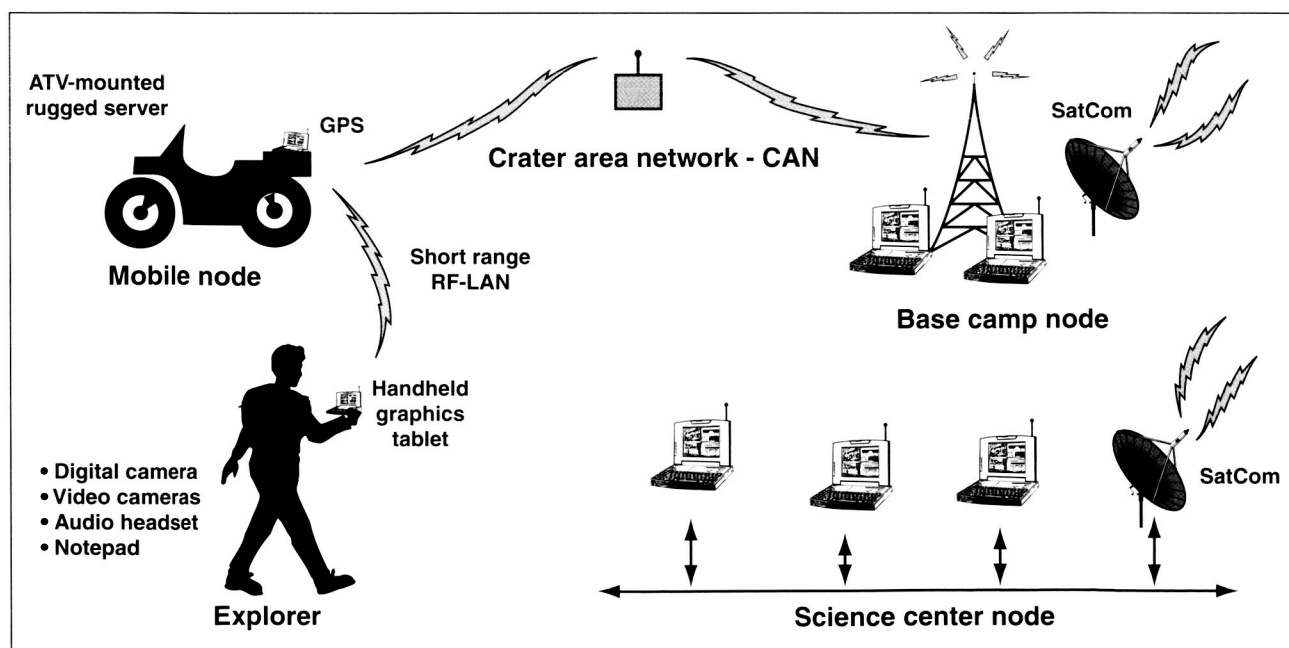


Fig. 1. The Mobile Exploration System.

ATV, which is continuously operated during traverses mapping the route in real time using a Global Positioning System (GPS). This system gives the explorers their location and a topographic map of the local area at all times. Additionally, video cameras allow people at base camp to view the terrain seen by the exploration party. Text or audio communications between the mobile node and base camp are also supported. Pen-based graphical tablets can be used to control the applications resident on the server, providing a human/computer interface usable in both rain and bright sun. Experiments in voice recognition and other user interface modalities are ongoing.

The primary goals for the FY99 field season were to test satellite communications, base-camp computational infrastructure, and the performance and deployment of the CAN radio systems. These goals were fully met, and resulted in certain design improvements.

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Development of the Vapor Phase Catalytic Ammonia Removal Process

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Ames Research Center (ARC) has recently completed the development and testing of a prototype Vapor Phase Catalytic Ammonia Removal (VPCAR) system that represents the next generation in spaceflight water recovery systems. Water is the single largest resupply requirement associated with human spaceflight, accounting for 87% by mass of an astronaut's daily metabolic requirement. The VPCAR system achieves a mass metric almost an order of magnitude better than the current state-of-the-art water processors. (Mass metric is a technique used to reduce all performance parameters into launch mass.) Incorporating the VPCAR technology into human spaceflight missions could potentially save hundreds of millions of dollars in resupply costs, depending on the specific mission scenario. As a

result, a human-rated version of the VPCAR technology has been authorized for development, and when completed it will be used for human testing in a closed chamber.

The VPCAR process is a two-step distillation-based water processor. The current configuration of the technology is shown in figure 1. The VPCAR process is characterized by the use of a wiped-film rotating-disk vacuum evaporator to volatilize water, small molecular weight organics, and ammonia. This vapor stream is then oxidized in a vapor phase catalytic reactor to destroy any contaminants. The VPCAR process uses two catalytic beds to oxidize contaminants and decompose any nitrous oxide (N_2O) produced in the first bed. The first catalytic bed oxidizes organics to carbon dioxide (CO_2) and water, and ammonia to N_2O and water. This oxidation reactor contains 1% platinum on alumina pellets and operates at about 523 kelvin (K). The second catalytic bed reduces the N_2O to nitrogen and oxygen. This reduction catalyst contains 0.5% ruthenium on alumina pellets and operates at about 723 K. The reactor and distillation functions occur in a single modular process step, no scheduled maintenance is required, and the system has no resupply requirements. The process achieves between 97 and 98% water recovery.

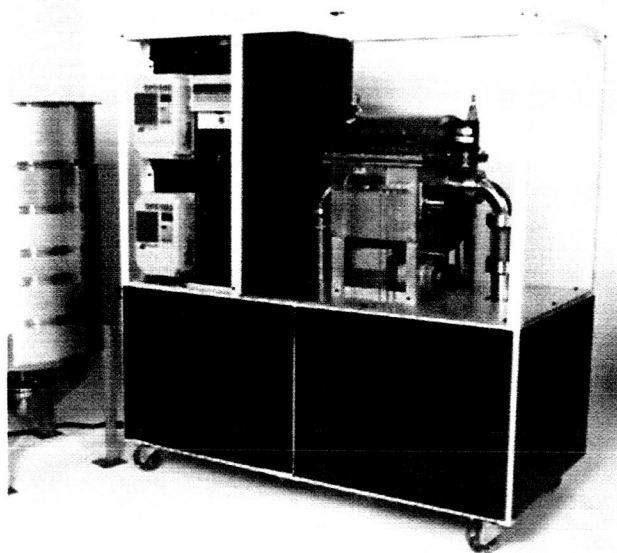


Fig. 1. Vapor Phase Catalytic Ammonia Removal (VPCAR) water recycling system.